Lunar Reconnaissance Orbiter: (LAMP)

Audience
Grades 6-8

Time Recommended
2-4 Hours

AAAS STANDARDS

- 1B/1: Scientific investigations usually involve the collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected evidence.
- F/5: Human eyes respond to only a narrow range of wavelengths of electromagnetic waves— visible light. Differences in wavelength within that range are perceived as differences of color.

NSES STANDARDS

Content Standard A (5-8): Abilities necessary to do scientific inquiry:

c. Use appropriate tools to gather, analyze and interpret data.

d. Develop descriptions and explanations using evidence.

e. Think critically and logically to make relationships between evidence and explanations

Content Standard B (5-8), Physical Science:

c. Transfer of energy: The Sun is a major source of energy for changes on the Earth's surface. The Sun loses energy by emitting light. A tiny fraction of that light reaches the Earth, transferring energy from the Sun to the Earth. The Sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

MATERIALS

- Student science notebook
- Student worksheet Part One
- Student worksheet Part Two
- Student worksheet Part Three
- Flashlight (one per group)
- Variety of light sources (lamps, fluorescent lights, sunlight; optional as available)
- Spectroscopic glasses or spectroscope (one per group)
- Prism (one per group)
- Gas Spectrum Emission Tubes (optional)
- Colored pencils, markers, or crayons

Learning About Light: Searching for Water on the Moon

Learning Objectives:

- To understand the electromagnetic spectrum.
- To understand the relationship between wavelength and frequency.
- To observe visible (white) light through a diffraction grading.
- To understand how NASA's Lunar Reconnaissance Orbiter uses different wavelengths to map the lunar surface of the Moon.

Preparation:

1. Photocopy the Part One worksheet for each group of three students.
2. Photocopy Part Two and Part Three worksheets for each student.
3. Make a color transparency of the electromagnetic spectrum for your class discussion (see supplemental resources section).
4. Mark off an approximately 10x20 foot area for students to walk either in the classroom or hallway. Designate a starting line and finish line. Make sure to equally divide areas for each group to walk so as to not cause collisions from amongst students.
5. If you plan on having the students build their own spectroscopes, they would need to complete this task before part three of this lesson.
6. Gather a variety of light sources for students to view through a spectroscope (flashlight, lamps, fluorescent lights, sunlight, etc.).
7. Obtain gas emission tubes for students to view and compare different spectra to that of visible light (optional).
8. Make a copy of the Lunar Reconnaissance Orbiter image for your class discussion (see supplemental resources section).

Background Information:

The electromagnetic spectrum is made of electromagnetic waves that span a large range of frequencies and wavelengths. Students should be familiar with various regions of the spectrum. Visible, or white light, is actually only a small region of the entire spectrum. When visible light is bent through a prism, it separates into distinct wavelengths, each with a particular color. The longest wavelengths in the visible light spectrum are red, while the shortest are violet. Beyond the violet range of the visible light spectrum is ultraviolet light. As a result, ultraviolet light is higher in frequency but shorter in wavelength than visible light.

Procedure:

PART ONE—VOCABULARY BUILDING

1. Display a transparency of the electromagnetic spectrum on the overhead. Inform students they will be learning about the electromagnetic spectrum.

2. Before students can explore the diagram of the spectrum, discuss some of the vocabulary concepts students will need to know- i.e. frequency, wavelength, visible light.

3. Assemble students into groups of three. Allocate each student in the group an activity assignment. One student will be the "long" walker; one student will be the "short" walker; one student will be the timer/counter. Give each group of students the Part One worksheet and discuss. Instruct groups to work together to complete the roles above. Note: make sure to provide enough room for each group of students to walk across from start to finish so as to not cause groups walking into one another. It will be important to monitor this situation throughout the activity— safety first.

4. Before allowing students to begin this activity, model the procedure in order to make sure all students understand the underlying instructions. Choose students to act as demonstrators regarding how to walk across the start/ finish line properly.

5. Discuss the group results as a class (see teacher answer key). Be sure to explain the relationship between frequency and wavelength in more detail (have students reference their results), so as to not perpetuate any misconceptions.

PART TWO—EXPLORING THE SPECTRUM

1. Give each student a copy of the Part Two worksheet. Students will be using the diagram of the electromagnetic spectrum to answer the questions on the worksheet.

2. Allow students to work with a partner or in a group of two/ three to explore the electromagnetic spectrum and answer the questions.

3. Review the worksheet as a class (see teacher answer key).

PART THREE—PLAYING WITH LIGHT

1. Assemble students into groups of three or four.

2. Provide the Part Three worksheet to each student.

3. Direct students to the diagram of the electromagnetic spectrum on the worksheet. Ask them about the section of the spectrum dealing with visible light. Discuss how the visible light range of the spectrum looks like a rainbow.

4. Give each group a pair of spectroscopic glasses (or a spectroscope) and a flashlight.

5. Allow students to explore light (using the flashlight and any other available light sources) with the spectroscope. Ask the students to record their observations in their science notebooks (they will use this data to produce a "Claims-Evidence" chart).

6. Collect the spectroscopes and give each group a prism. Ask the students to see if they can use the prism to separate "white" light into its component colors.

7. Allow students to explore. Ask them to record their specific procedures and observations again in their science notebooks.

8. Ask students to complete the "Claims-Evidence" chart, listing some conclusions about the focus question stated at the beginning of the worksheet. Remind them to look at their observations made in their science notebooks.

9. Lead a class discussion about the results of the activity. Students should share their observations/ conclusions (found in their science notebooks/ individual worksheets) and use them to support their answers to the focus question in the Part Three worksheet.

10. Optional: if you have the resources available, allow students to view gas emission tubes through the spectroscopes. Have them record their observations and compare their results to the spectrum of visible light. Have a discussion with students regarding how scientists use this type of information in the study of astronomy (see teacher resources).

PART FOUR— CONNECTION WITH LRO

1. Discuss that a spacecraft, the Lunar Reconnaissance Orbiter (LRO), is currently detecting wavelengths other than visible light in order to map the lunar surface of the Moon. Specifically mention one of the instruments, LAMP, is measuring the ultraviolet wavelength to identify locations on the Moon that previously were permanently shadowed, or unseen to us. This instrument is specifically searching these lunar dark regions for any exposed water ice deposits. It can do so because water ice on the surface will leave a distinct imprint in the reflected light detected by the LAMP instrument, definitively confirming its presence. This is one of the main goals for the entire LRO mission.

worksheet

ELECTROMAGNETIC SPECTRUM BASICS
Part One

Name _____

1. Using the longest strides (or steps) possible, the long walker will walk from the start to the finish line. Record the number of steps taken.

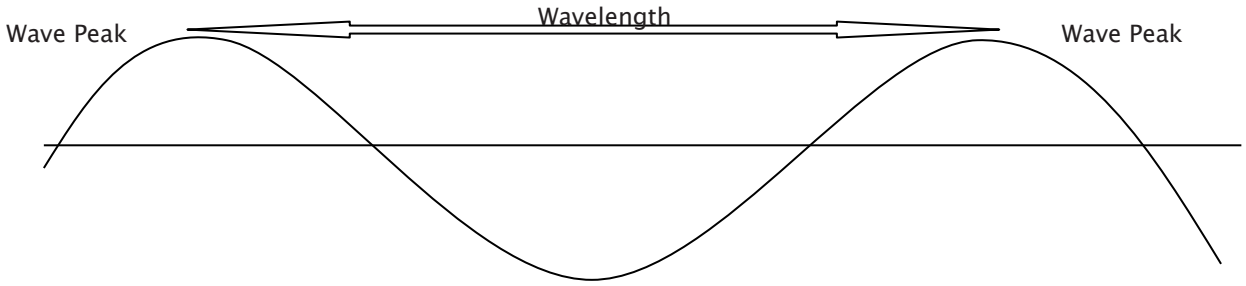
2. Using the shortest strides (or steps) possible, the short walker will walk from the start to the finish line. Record the number of steps taken.

3. The long walker and short walker will now walk at the same time. The walkers MUST stay together the entire distance and reach the finish line at the same time.

4. Whose feet were moving the fastest during step 3?

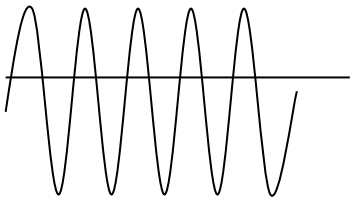
5. The long walker will take one step. The short walker will take as many steps as it takes to reach the long walker. Record the number of steps it takes for the short walker to make one long walker step.

6. The electromagnetic spectrum uses two terms to describe waves of light. The **wavelength** is the distance between two peaks of a wave.

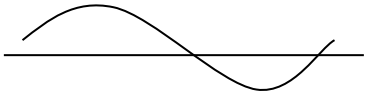


Which part of the walking activity could represent **wavelength?**

7. The second term used to describe waves on the electromagnetic spectrum is **frequency**. The **frequency** of a wave is the number of waves that pass a certain point in a given amount of time.



High frequency wave



Low frequency wave

Which part of the walking activity could represent **frequency?**

8. Think about the long walker.

Did the long walker have a long or short wavelength?

Did the long walker have a high or low frequency?

9. Think about the short walker.

Did the short walker have a long or short wavelength?

Did the short walker have a high or low frequency?

worksheet

10. Write a rule about wavelength and frequency.

If a wave has a long wavelength, it has a _____ frequency.

If a wave has a short wavelength, it has a _____ frequency.

11. Look at the electromagnetic spectrum. Which type of wave could the long walker represent?

12. Look at the electromagnetic spectrum. Which type of wave could the short walker represent?

worksheet

LEARNING ABOUT LIGHT
Part Two

Name _____

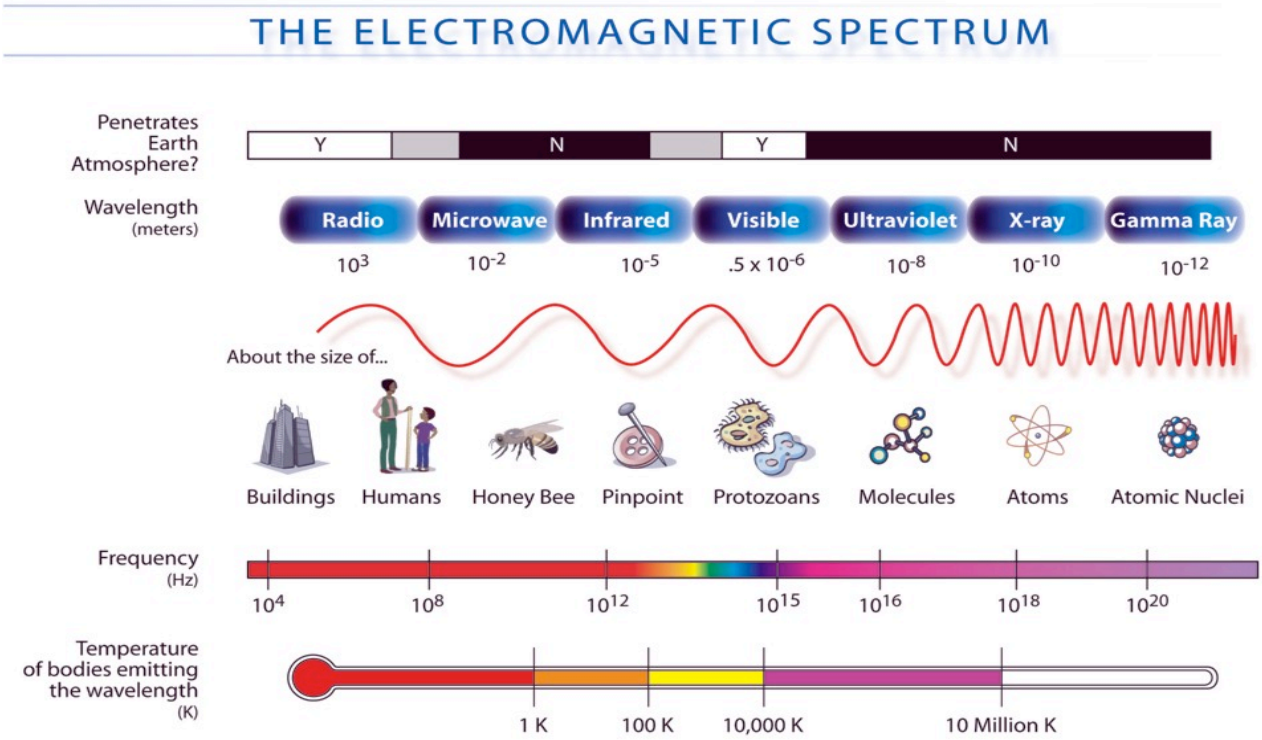
Building Background Knowledge:

You may know things about the electromagnetic spectrum. The words on the left of this table are some regions of the electromagnetic spectrum. Think about how or where you have heard these words before and describe what you know.

Region of the EM Spectrum	I know…
Radio	
Microwave	
X-Ray	
Ultraviolet	

worksheet

Review the diagram of the electromagnetic spectrum. Use the diagram to answer the questions.



1. The area of the electromagnetic spectrum with the largest waves (wavelength) is _____.

2. The area of the electromagnetic spectrum with the smallest waves (wavelength) is _____.

3. Visible light falls between the _____ and _____ regions on the electromagnetic spectrum.

4. Ultraviolet waves are _____ than visible light waves. (shorter or longer)

5. Look at the visible light section on the frequency scale of the electromagnetic spectrum. It is spilt into a rainbow of colors. Which color is on the side with the longest wavelengths in the spectrum?

6. Which color is on the side of the visible range with the shortest wavelengths in the electromagnetic spectrum?

7. Look at the electromagnetic spectrum. Color the chart below to show the visible light region on the electromagnetic spectrum. Pay particular attention to how much of the visible light spectrum is made of each color.

Long Wavelength — Short Wavelength

worksheet

VISIBLE LIGHT
Part Three

Name _____

Question:
"How do we know visible light is made up of the colors within the rainbow?"

Make a Claim/ Evidence chart related to the question above. Use your notes of the procedures and observations made in your science notebook while working with visible light:

Claim	Evidence

SUPPLEMENTAL IMAGES/ MATERIALS/ RESOURCES:

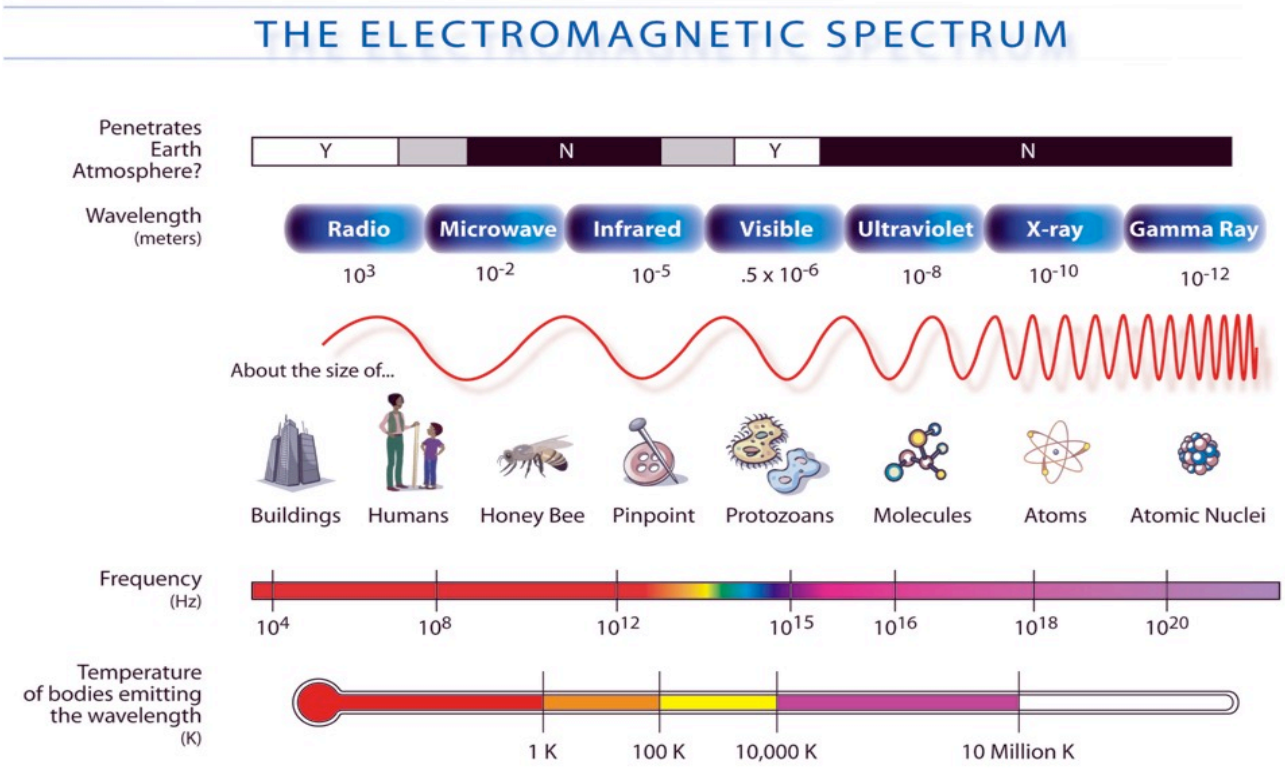


Image from: http://www.google.com/imgres?imgurl=https://mynasadata.larc.nasa.gov/images/EM_Spectrum3-

ELECTROMAGNETIC SPECTRUM BASICS
Part One

1. Using the longest strides (or steps) possible, the long walker will walk from the start to the finish line. Record the number of steps taken.

   Answer Varies

2. Using the shortest strides (steps) possible, the short walker will walk from the start to the finish line. Record the number of steps taken.

   Answer Varies

3. The long walker and the short walker will now walk at the same time. The walkers MUST stay together the entire distance and reach the finish line at the same time.

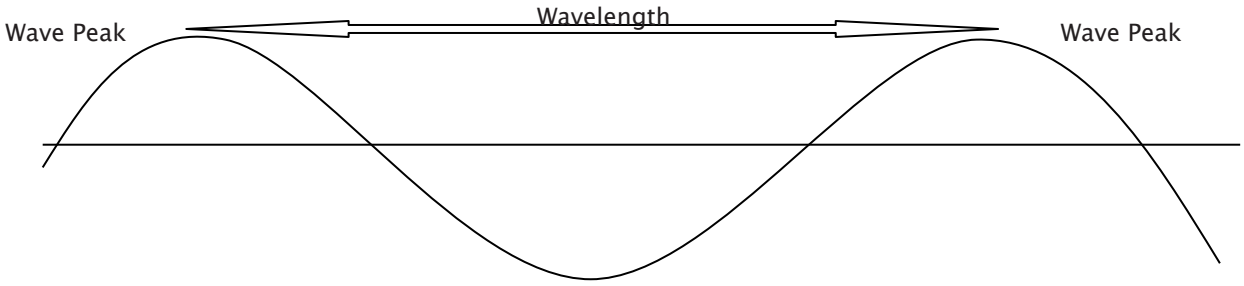
4. Whose feet were moving the fastest during step 3?

   Short Walker

5. The long walker will take one step. The short walker will take as many steps as it takes to reach the long walker. Record the number of steps it takes for the short walker to make one long walker step.

   Answer Varies

6. The electromagnetic spectrum uses two terms to describe waves of light. The **wavelength** is the distance between two peaks of a wave.

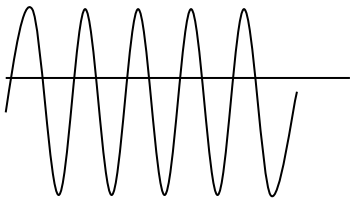


   Which part of the walking activity could represent **wavelength?**

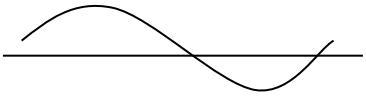
   The length of student strides

Teacher Answer Key

7. The second term used to describe waves on the electromagnetic spectrum is the **frequency**. The **frequency** of a wave is the number of waves that pass a certain point in a given amount of time.



High frequency wave



Low frequency wave

Which part of the walking activity could represent **frequency?**

The number of steps each student was taking

8. Think about the long walker.

Did the long walker have a long or short wavelength? **Long**

Did the long walker have a high or low frequency? **Low**

9. Think about the short walker.

Did the short walker have a long or short wavelength? **Short**

Did the short walker have a high or low frequency? **High**

10. Write a rule about wavelength and frequency.

If a wave has a long wavelength, it has a **Low** frequency.

If a wave has a short wavelength, it has a **High** frequency.

11. Look at the electromagnetic spectrum. Which type of wave could the long walker represent?

Radio waves, microwaves

12. Look at the electromagnetic spectrum. Which type of wave could the short walker represent?

Gamma rays, x-rays

LEARNING ABOUT LIGHT
Part Two

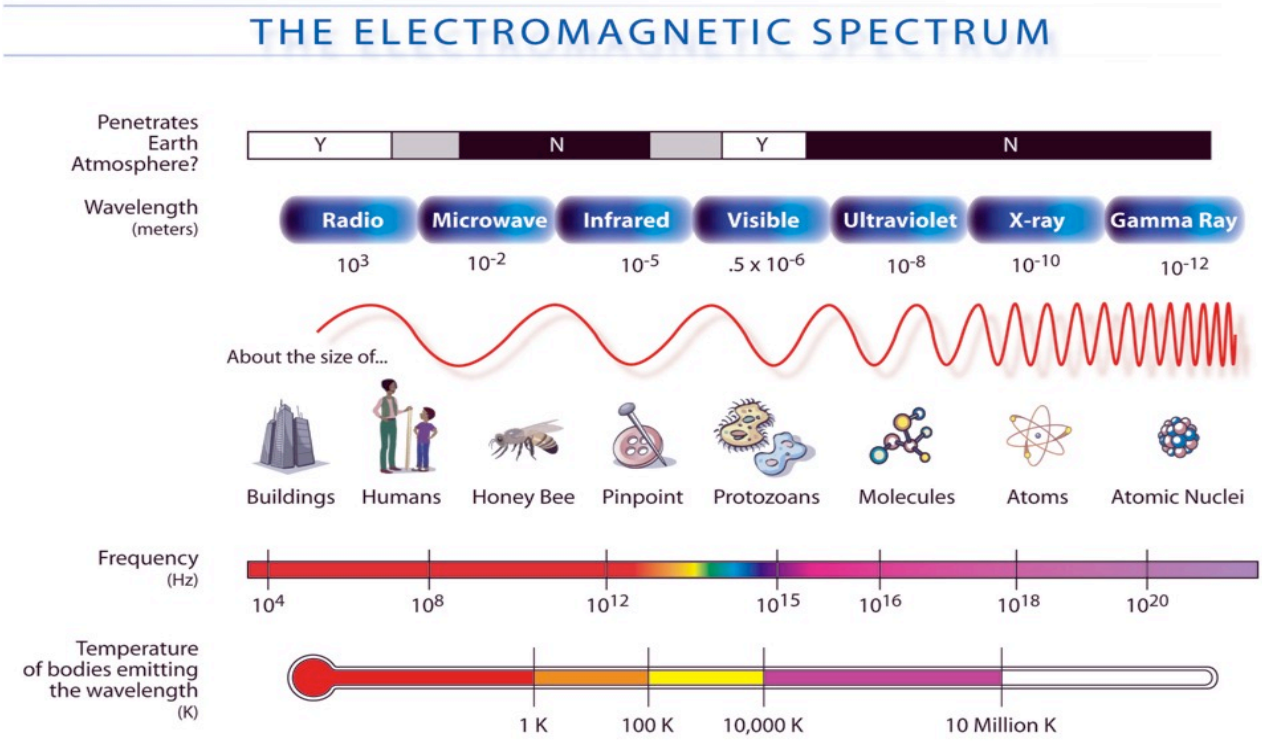
Building Background Knowledge:

You may know things about the electromagnetic spectrum. The words on the left of this table are some regions of the electromagnetic spectrum. Think about how or where you have heard these words before and describe what you know.

Region of the EM Spectrum	I know…
Radio	**Student answers will vary.**
Microwave	**Student answers will vary.**
X-Ray	**Student answers will vary.**
Ultraviolet	**Student answers will vary.**

Teacher Answer Key

Review the diagram of the electromagnetic spectrum. Use the diagram to answer the questions.



1. The area of the electromagnetic spectrum with the largest waves (wavelength) is **Radio**.
2. The area of the electromagnetic spectrum with the smallest waves (wavelength) is **Gamma rays**.
3. Visible light falls between the **Infrared** and **Ultraviolet** regions on the electromagnetic spectrum.
4. Ultraviolet waves are **Shorter** than visible light waves. (shorter or longer)
5. Look at the visible light section on the frequency scale of the electromagnetic spectrum. It is spilt into a rainbow of colors. Which color is on the side with the longest wavelengths in the spectrum? **Red**
6. Which color is on the side of the visible range with the shortest wavelengths in the electromagnetic spectrum? **Violet**
7. Color the chart below to show the visible light region on the electromagnetic spectrum. Pay particular attention to how much of the visible light spectrum is made of each color.

Long Wavelength — Short Wavelength

Teacher Resources:

Build your own spectroscopes:
http://www.exploratorium.edu/spectroscope
http://sci-toys.com/scitoys/scitoys/light/cd_spectroscope/spectroscope.html

Additional activities about light, color, and the EM spectrum:
http://spaceplace.jpl.nasa.gov/teachers/eo3_spectroscopy.pdf
http://www.exploratorium.edu/spectra_from_space/ultra_activity.html
http://imagine.gsfc.nasa.gov/docs/teachers/lessons/roygbiv/roygbiv.html

More information about the electromagnetic spectrum:
http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html

Electromagnetic spectrum graphic:
http://www.google.com/imgres?imgurl=https://mynasadata.larc.nasa.gov/images/EM_Spectrum3-

Lunar Reconnaissance Orbiter graphic/ information:
http://www.nasa.gov/mission_pages/LRO/multimedia/lroconcept3.html
http://www.boulder.swri.edu/lamp

For purchasing rainbow glasses or diffraction gratings:
http://www.rainbowsymphonystore.com
https://www.scitoyscatalog.com
http://sciencekit.com/diffraction-grating/p/IG0024032